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# HAWAIIAN SHALLOW WATER ANTHOZOA

BY

ADDISON E. VERRILL

BERNICE P. BISHOP MUSEUM

BULLETIN 49

HONOLULU, HAWAII  
PUBLISHED BY THE MUSEUM  
1928



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ADDISON E. VERRILL, PROFESSOR OF ZOOLOGY, YALE UNIVERSITY 1864-1907, PROFESSOR EMERITUS 1907-1926, DIED DECEMBER 10, 1926. THE LAST TWO YEARS OF HIS LIFE WERE SPENT IN HAWAII, WHERE HE GAVE MUCH OF HIS TIME TO COLLECTING ON THE REEFS OF KAUAI AND OAHU, AND TO A STUDY OF THE COLLECTIONS IN BISHOP MUSEUM. AMONG MANUSCRIPTS LEFT BY PROFESSOR VERRILL WAS AN INCOMPLETE PAPER ON HAWAIIAN ANTHOZOA, WHICH HAS BEEN PREPARED FOR PUBLICATION BY CHARLES HOWARD EDMONDSON.

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# Hawaiian Shallow Water Anthozoa

By ADDISON E. VERRILL

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## INTRODUCTION

Hitherto, no truly shallow water Alcyonaria nor Antipatharia have been recorded from Hawaii so far as known to me. In 1899 I described a shallow water actinian under the name of *Bunodactis manni* (Am. Jour. Sci., vol. 7, p. 218, 1899), and Dana (U. S. Explor. Exped., Zoophytes, 1846) described a genuine "red coral" as *Corallium secundum* which undoubtedly came from rather deep water and does not appear to have been taken in later years. The Alcyonaria collected by the *Albatross* all came from water more than 10 fathoms deep. Gorgonians and Alcyonacea appear to be almost entirely lacking in shallow water and on coral reefs of Hawaii, although both groups are generally abundant around all the Polynesian and Micronesian islands, as well as in the shallow waters of the East Indies, Australia, India, and the Red Sea. The rarity of these groups here is remarkable, but ascidians, hydroids, and polyzoa are also few.

The only Hawaiian reef-dwelling alcyonarian that I have been able to study is a thin, encrusting, soft species, referred to a new genus, *Sarcothelia*. In the Bernice P. Bishop Museum is a large, branching, nearly naked, black axis of a gorgonian, there described as *Euplexaura neglecta*, new species. It may have come from Hawaiian waters long ago. There is also a very large black *Antipathes* (*A. grandis* Verrill) from Maui, and another smaller species obtained from a shark's stomach. In the same collection, is a small dry gorgonian that proved to be a very interesting new species of a rather remarkable new genus (*Allogorgia exserta*). Its origin is unknown. It may have come from Hawaiian waters, caught on fish lines in deep water. A careful search of the bays and reefs in shallow water by various collectors during many years, as well as by me during several months, has failed to discover any living gorgonian. Nor so far as known have any species of *Spongodes* (or *Dendronephthya*), so numerous on Polynesian and Australian reefs and shallows, been found. However, several new and interesting species of actinians have been obtained by me and by others, and several species were previously known but not yet described. Three species were found living in the public aquarium at Honolulu.

I am much indebted to Prof. Charles H. Edmondson for several good photographs of living actinians, and for a photograph of a living specimen of *Sarcothela edmondsoni*. Mr. Edwin H. Bryan, Jr., also kindly made some of the photographs here reproduced from preserved specimens. To Dr. C. Montague Cooke, Jr., I am indebted for living specimens of four new species of actinians from Oahu, among them a very large and interesting species of a new genus (*Macranthea cookei*), and a small and curious species, capable of swimming like a little jelly-fish (*Nectothela lilae*) from the same place.

One of these species is of peculiar interest because it is constantly carried about held in the claws of two species of crabs. It is used by the crabs as a means of protection from their enemies, like a pair of small shields, for fishes are afraid of the stinging organs (cnidae) of all actinians. This actinian, although its habits have been long known to writers, has not been named nor properly described by anyone, so far as I know.<sup>1</sup> Indeed, it is doubtful whether adult specimens have been collected, so that its generic position has been doubtful. I have here described and figured it from life, photographs, and alcoholic specimens, together with its two commensal crabs as *Sagartia pugnax*, but I was not able to procure living specimens.

[All the figures in the manuscript are reproductions of drawings by Professor Verrill. Some of the half-tones, however, were made from type specimens after the manuscript was received for publication. The American Museum of Natural History, where most of the Verrill collection of Hawaiian Anthozoa is deposited, kindly loaned material for examination.—C. H. E.]

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<sup>1</sup> The actinian mentioned by Mr. Verrill was referred to the genus *Bunodeopsis* by J. E. Duerden. Rathbun, M. J. (U. S. Fish Comm. Bull., vol. 23, pt. 3, p. 866, 1903) under *Lybia tessellata*. C. H. E.



## Subclass ALCYONARIA

## Order ALCYONACEA VERRILL, 1865

## ANTHELIDAE Verrill, New Family

Alcyonoid polyps that arise by budding from adherent stolons or membranes. The bodies are soft without calicles or anthocodia. They are more or less muscular and changeable in size and form, but not retractile. Tentacles elongated, changeable in form, but usually not retractile. Spicules may be absent; when present usually small and simple.

Besides the new genus here described the family Anthelidae should include *Anthelia*, *Rhizozenia*, and some other allied genera.

## SARCOTHELIA Verrill, New Genus

Forms thin, soft membranous incrustations and stolons on such bases as dead corals, from which arise numerous elongated, soft, imperfectly contractile polyps, varying much in form and thickness according to the state of contraction of the circular muscles. The tentacles are elongated and rather slender in expansion, with numerous pinnae in four rows. Spicules appear to be entirely lacking. It is allied to *Anthelia*, but typical species of *Anthelia* are said to have spicules.

***Sarcothelia edmondsoni*** Verrill, new species (Pl. I, *A*; fig. 1, *a-e*).

The living specimens form low groups of very numerous soft-bodied polyps arising close together from a thin soft encrusting membrane, many of them several inches in breadth, attached to coral reef rock or dead corals. Around the margins some polyps stand on short stolons, and young polyps bud from such stolons. The mature polyps are crowded, many of them nearly or quite in contact at their bases, and most of them about equal in height. In full expansion they are 5 to 7 mm. high. The body when expanded is usually elongated, slender cylindrical, or slightly more enlarged distally. There are no calicles nor anthocodia. The disk is small; the tentacles are subterete, long and slender in full extension, widest in the middle, most of them obtusely pointed, about twice as long as the breadth of the disk. They have about 10 or more pairs of short pinnae, the middle ones longest, in many species standing in 4 lines, those on each side alternating. When taken out of water the living polyps become collapsed, short and flabby, and the tentacles and pinnae contract to about half their full length. There are no spicules in any part. The color of the basal membrane and polyp bodies is light ocher-color or buff, and translucent; the color of tentacles by reflected light is pale lilac, but light brownish by transmitted light, perhaps due to the abundance of yellowish eggs. Breadth of the type colony is about 50 by 80 mm.; height of individual polyps 5 mm. or more; diameter of column in full expansion, about 2 mm.

When preserved in alcohol, the polyp bodies contract strongly and take various forms. Many become long and slender for their whole length and show numerous strong transverse wrinkles due to contraction in length; others remain larger near the summit; while some remain enlarged for half the length or more, but are strongly contracted toward the base (fig. 1, *a-d*), showing that the column has both

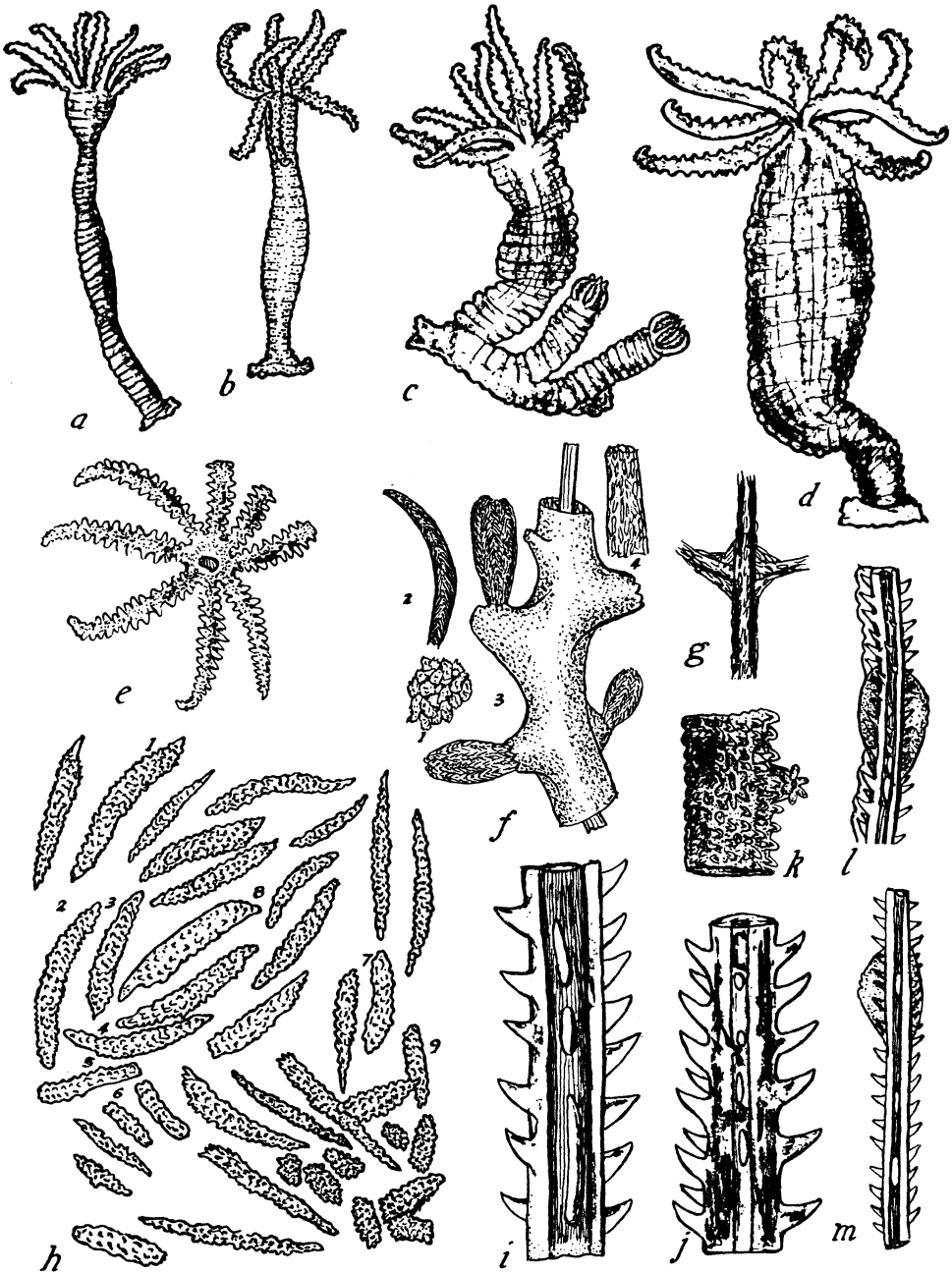


FIGURE 1.—*a-e*, *Sarcothelia edmondsoni* Verrill: *a*, *b*, expanded polyps ( $\times 10$ ), *c*, group of partially contracted polyps ( $\times 15$ ), *d*, partially contracted polyp ( $\times 25$ ), *e*, oral view of a polyp ( $\times 10$ ), *f-h*, *Allogorgia exserta* Verrill; *f*, details of a portion of a branch—1, surface under low magnification, 2, portion of tentacle of polyp, 3, stem with dried polyps partially restored ( $\times 14$ ), 4, portion of small branch with spicules in place—*g*, branch near tip of colony, *h*, group of spicules; *i-m*, *Antipathes grandis* Verrill; *i-j*, sections of larger branches showing spinules ( $\times 3$ ), *k*, branch with polyps partially restored ( $\times 5$ ), *l-m*, branches of a smaller specimen determined by Mr. Verrill to be of the same species ( $\times 4$ ).

circular and longitudinal muscular fibers well developed. The tentacles also contract in various ways, but relatively more in size than in length as shown in figure 1.

All parts of the column and tentacles contain many minute cnidocils, most numerous in the tentacles. No commensal unicellular algae were found in the polyps examined, so that the colors appear to belong to the tissues.

This species has the same form and manner of growth as *Anthelia lineata* Stimpson, from Hong Kong (Verrill, Essex Inst., Salem, Mass., Proc., vol. 4, p. 193, pl. 6, figs. 9-9b, 1865), except that *A. lineata* has very different colors; the column is conspicuously marked with eight longitudinal lead-colored stripes and the tentacles are blue. It covered the rocks at low tide with extensive groups, forming a thin film. The type was destroyed in the great Chicago fire. It was not examined for spicules.

Several colonies of this new Hawaiian species were found in shallow water on the coral reef at Waikiki, Oahu, by Professor C. H. Edmondson. The type was kept alive in an aquarium by him, where I studied it. Type specimen in the Bernice P. Bishop Museum.

#### Order GORGONACEA Verrill, 1865

#### ALLOGORGIDAE Verrill, New Family

The family Allogorgidae is instituted to include a new genus of gorgonians in which the axis is composed of a flexible, continuous translucent cementing material, soluble in Javelle water, and containing numerous detached spicules as a reinforcement. The coenenchyma is of moderate thickness, with minute pores in the surface in the type. The calicles are relatively large and exsert. The tentacles are long, not retractile, folded together with the tips incurved in the type. They contain an abundance of elongated rough spicules arranged in chevrons.

Another new genus, somewhat related, is found in deep water in the West Indies. In that genus the axial spicules are united together forming flat areas with circular openings.

#### ALLOGORGIA Verrill, New Genus

Axis firm and brittle, consisting of a translucent or amber-colored substance, filled with simple oblong or billet-shaped relatively large spicules more or less closely united by the cementing substance but not coalescent, becoming very distinct in the slender branches. Longitudinal adaxial canals are regular, relatively large. The coenenchyma is firm, moderately thick, having an inner layer of elongated, acute, rough, spindle-shaped spicules, and an outer close layer of small, roundish, irregular or rough, granule-like spicules, between which small pores like pin pricks are visible when much enlarged, giving the surface a finely roughened or sponge-like appearance. The calicles are relatively large and prominent, apertures minutely 8-dentate. The

polyps have large and long tentacles covered on the outer side with a double row of large spicules arranged chevronwise, rendering the tentacles rather rigid and incapable of retraction. When dried, most of them are usually brought closely together with incurved tips.

**Allogorgia exserta** Verrill, new species (Pl. I, *B*; fig. 1, *f-h*).

Type openly branched in one plane; the branchlets are slender and do not form reticulations. Height about 125 mm.; breadth about 100 mm., but it probably is not an entire specimen. It has long been dried. Color is now pale purple or wine-red when wet. The calicles are large, most of them lateral, swollen at base, truncate-conical, with eight minute obtuse denticles at the edge. Tentacles, when dried, are large, rigid, covered with abundant brownish spicules in chevrons, and most of them folded together with the tips incurved. Many are longer than the calicles.

The surface of the coenenchyma appears minutely and roughly granular under a simple lens, but when more enlarged it appears sponge-like with many minute pores. The larger spicules from the tentacles are orange-brown, most of them more or less curved spindles, blunt at both ends; others are acute at one end and blunt at the other, thus becoming slightly club-shaped. Most spicules are rather sparsely covered with small irregular warts, particularly toward the larger proximal end. Some are strongly curved, others nearly straight. Probably most of the smaller spicules come from the pinnae. They are flattened and blunt or rounded at both ends (fig. 1, *h*, 5, 6). Others are acute warted spindles. Most of the larger rod or bullet-shaped spicules from the axis, some of them dark orange in color, are 0.20 to 0.16 mm. in diameter, but vary in length from 0.64 to 1.06 mm.; their length is about 0.70 to 0.80 mm.

The larger spicules from the tentacles, like 1, 2, 3, 4 (fig. 1, *h*), measure  $1.10 \times 0.12$ ;  $1.14 \times 0.12$ ;  $1.10 \times 0.60$ ;  $0.90 \times 0.12$ ;  $0.90 \times 0.08$ ;  $1.00 \times 0.16$ ;  $0.80 \times 0.16$ ;  $0.80 \times 0.10$  mm. Others, like 5, 6, measure  $0.70 \times 0.12$ ;  $0.56 \times 0.16$  mm. Small ones like 7, measure  $0.40 \times 0.12$ ;  $0.12 \times 0.12$ ;  $0.16 \times 0.12$ . Some of those from the axis, like 8, 9, measure  $0.72 \times 0.20$ ;  $0.70 \times 0.20$ ;  $0.62 \times 0.20$ ;  $1.06 \times 0.20$ ;  $0.80 \times 0.16$ ;  $0.76 \times 0.20$ ;  $0.64 \times 0.20$  mm.

Type specimen in Bernice P. Bishop Museum. Its origin is not known.<sup>2</sup>

PLEXAURIDAE Gray, 1859; Verrill, 1869, emended.

**Euplexaura neglecta** Verrill, new species (Pl. II, *A*).

A large, stout species, with a black axis, which is much branched, nearly in a plane. Some of the lower branches are reticulated irregularly; terminal ones are slender and flexible. Branching is mostly dichotomous. Near the base the axis is about 15 mm. in diameter. The total height is about 15 inches (375 mm.); breadth about 18 inches (475 mm.). The axis is externally calcareous at and near the base, but mostly chitinous elsewhere. The coenenchyma remaining in patches, is moderately thick, yellowish brown, nearly smooth. The calicles are very small, scattered, not numerous, wholly immersed, or flush with the general surface.

The spicules are rather minute, and of several forms, including spindles, double-spindles or girdled spindles, rough clubs, longer and shorter. These are all covered with rough, prominent verrucae.

Type specimen in Bernice P. Bishop Museum.

<sup>2</sup> There is doubt that this specimen is Hawaiian. Bishop Museum catalog No. 2741 is a gorgonian taken by the *Albatross* at  $80^{\circ} 34'$ , W. Long. and  $7^{\circ} 06'$  N. Lat. This specimen follows as No. 2742, being entered as "ditto" with reference to the *Albatross*, but without mention of locality. (C. H. E.)

## Order ANTIPATHARIA Verrill, 1865

Anthozoa that secrete simple or branched, horn-like axial structures, either smooth or spinulose, not sulcated, surrounded by a thin, fleshy membrane. Polyps with few, simple tentacles, in many specimens only six.

## ANTIPATHIDAE

**Antipathes grandis** Verrill, new species (Pl. II, B; fig. 1, *i-m*).

A very large (about 54 inches tall) and much branched species, the branches dividing in an arborescent manner. The divisions are often dichotomous, and the branches rarely anastomose. The naked axis is black and in many specimens lustrous in the main stalk and larger branches. In the smaller branches it is dusky brown to yellowish brown; in the slender terminal twigs, which are flexible, it is yellow. After soaking in Javelle water or potash the smaller branches are seen to be hollow. In sections the larger branches are more or less elliptical. The spinules on the larger branches are irregularly scattered and scarcely visible except under a good lens, and are not crowded. In other places they are in regular rows and close together, particularly on the slender terminals where they form two or three regular rows, many of them nearly in contact at their bases, and thus covering nearly the whole surface. They are compressed laterally and have small and very acute tips, usually inclined upwardly at an angle of nearly 45 degrees.

This species in size and general appearance resembles *A. arborea* of Dana, from the Fiji Islands (U. S. Expl. Exped., Zoophytes, p. 584, pl. 56, figs. 2-26, 1846) and of Pourtales (Mus. Comp. Zool., Bull., vol. 6, no. 4, pl. 3, fig. 21, 1879-1881). But in *A. grandis* the branchlets are more slender and much more numerous and the spinules are much smaller, more numerous, and very different in form. In *A. arborea* they are strong, much compressed, perpendicular.

Many described species, including *A. dichotoma* Pallas, *A. arborea* Dana, *A. foeniculaces* Pallas, *A. virgata* Esper, *A. furcata* Gray, *A. gracilis*, von Koch, and *A. grandiflora* Silberfeld, were united by Van Pesch (Siboga Exped., Monograph 17, p. 52, 1914), who recorded species from Borneo, Flores, Sulu Sea, Arafura Sea, Kei Islands, Timor Sea and elsewhere.

The types of *A. dichotoma* Pallas and *A. foeniculaces* Pallas were from the Mediterranean Sea. Brook (Voyage "Challenger," vol. 32, p. 100, 1889) kept these separate from *A. arborea*. The spinules of *A. dichotoma* are large and strong, often half as long as the diameter of the branchlet and stand perpendicularly, with a broad compressed base.

Type, taken from off island of Maui, in Bernice P. Bishop Museum.

***Antipathes* (?) *irregularis* Verrill, new species (Pl. II, C; fig. 2, a-b)**

A small, very irregularly branched species, known only from the nude axis taken from the stomach of a shark. It is peculiar in being almost completely smooth, not having any real spinules recognizable when magnified 50 diameters, nor any trace of longitudinal grooves, such as occur on the axis of nearly all gorgonians. Therefore its position in the restricted genus *Antipathes* is doubtful. It cannot be positively determined until its soft integument is studied.

The axis in the larger branches is perfectly black, with a surface which appears somewhat as if polished. Such minute prominences as occur are irregular-conical, and may be due to the breaking off of small branchlets. The smaller branches are slightly translucent and diverge at all angles; some anastomose irregularly. Most of the axils are somewhat expanded and flattened. The terminal branchlets are very slender, pale yellow, and some show transverse internal rings of lighter and darker shades. The base is expanded and shows in some places numerous faint radial striations. Height 150 mm.; breadth 110 mm.

From the stomach of the tiger shark (*Galeocerdo tigrinus*) off Nihoa Island, Tanager Expedition, May 24, 1923.

Type specimen in the Bernice P. Bishop Museum.

**Order ACTINACEA Verrill, 1865****ANEMONIDAE (formerly ANTHEADAE)**

Actinians of various forms, destitute of any definite sphincter muscle and therefore incapable of retracting the tentacles or involuting the disk. The column may be smooth or provided with adhesive suckers, or with marginal tubercles (acrorhagi) pigmented or plain. Most tentacles are very numerous and slender and are able to contract in length and size, but not able to withdraw. Acontia are lacking. Fertile mesenteries are numerous in many cycles.

**MACRANTHEA Verrill, New Genus**

Column large, elongated in full extension, and tapered to the small base, which is used for burrowing in sand. The body is smooth on the lower portion, but furnished toward the upper end with rows of verruciform suckers, used for the attachment of sand, gravel, or broken shells; the upper ones are larger, prominent, many of them papilliform; the uppermost ones are on a submarginal fold, below a narrow fossa.

Tentacles are numerous and in many cycles; 6 of the first cycles are large and near the mouth; 12, in the second cycle, are also on the inner portion of the disk; outer tentacles become gradually smaller, very numerous and crowded toward and at the margin. There may be 6 or more cycles in large specimens.

The tentacles do not appear to be retractile when handled, nor when put into alcohol, but can contract to less than half their length and breadth. The column can contract much in length and size, but does not ordinarily involute the disk and margin, and seems to be unable to do so.

In transverse sections many mesenteries are perfect, but without gonads and their musculature is weak and diffuse. Gonads are borne on the smaller mesenteries, even on those of the sixth and seventh cycles, which are very narrow.

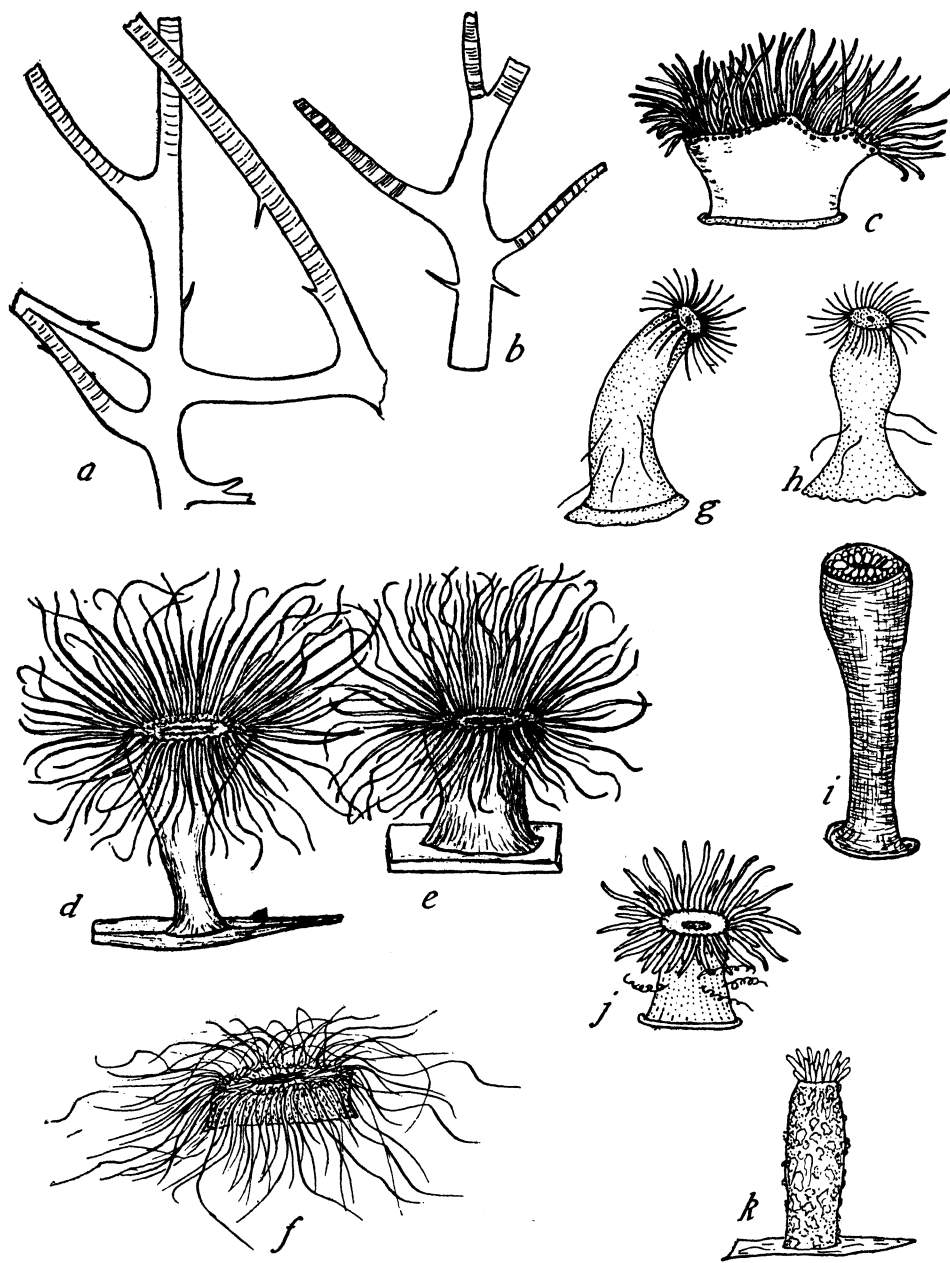


FIGURE 2.—a, b, *Antipathes* (?) *irregularis* Verrill, some of the finer branches near the tip of the colony ( $\times 8$ ); c, *Anemonia* (*Anthea*) *mutabilis* Verrill, partially contracted (natural size); d-f, *Nectothela lilae* Verrill: d-e, expanded and partially contracted, respectively ( $\times 2$ ), f, completely contracted as in the free swimming condition ( $\times 2$ ); g-h, *Sagartia pusilla* Verrill, g, expanded, h, partially contracted ( $\times 4$ ), in each specimen acontia (stinging threads) are shown extending through the body wall; i, *Sagartia longa* Verrill, extended with tentacles partially retracted ( $\times 1\frac{1}{2}$ ); j, *Sagartia pugnax* Verrill, fully expanded with acontia (stinging threads) extended through the wall ( $\times 2$ ); k, *Phellia humilis* Verrill, expanded showing the surface coated with grains of sand and other foreign material ( $\times 3$ ).

**Macranthea cookei** Verrill, new species (Pl. III, A).

A large, conspicuous, elongated actinian, living buried in sand nearly up to the margin, which carries fragments of shells, coarse sand, and similar material attached firmly to the submarginal suckers.

The disk and numerous tentacles in full expansion may be  $4 \pm$  inches in diameter, as displayed at the surface of the sand, while the body beneath the sand may be nearly a foot long and nearly 2 inches in diameter in the upper part.

The tentacles are very numerous and unequal, in 6 to 8 cycles in large specimens, so that their number may amount to 600 or more. They are of moderate length, rather stout, rapidly tapered. Many are curved in all directions, but none was seen retracted. As preserved they are about half as long as when living. When expanded in dishes the larger inner ones are 15 to 20 mm. long and 2 or more mm. in diameter, but in the sea they may be 20 to 25 mm. long. The outer ones are much shorter and smaller. The mouth is large, with a deep gonidial groove at each end, bordered by strong folds and with four prominent lobes on each side. The gonidial folds become wide in the stomodeum and extend considerably below it as lappets or ligulate appendages.

The 6 inner tentacles are very near the mouth and the 12 of the second cycle are not far from the mouth. The outer ones, very much crowded toward the margin, become small and short at the margin.

The column for much of its length is smooth and lubricous. In its burrows it is long and tapered to the rather small basal disk, which adheres to such objects as pebbles, but when removed it contracts much in length, becomes cylindrical and transversely wrinkled. The basal disk may then be as wide or even wider than the adjacent column.

The upper margin of the column is raised into a fold and slightly crenulated. For a short distance below the margin there are many rows of large adhesive suckers. The upper ones are larger and higher than the others and may have large sand grains or fragments of shells of considerable size firmly attached, as shown in Plate III, A. Many large specimens have the margin waved or frilled in expansion, and considerably broader than the column, when living. The stomodeum is large and in some preserved specimens is everted.

The color of the column for about one-half or two-thirds of its height is commonly pale flesh-color, yellowish white, or ochraceous, but varies to pinkish. It is more or less translucent with the mesenterial lines showing through faintly as pale lines. The upper part where sand grains adhere, perhaps about 30 to 50 mm. in length, is dark grayish or yellowish brown, in some specimens tinged with blue or lilac. The basal disk is colored like the column. The tentacles in some specimens studied are nearly all plain pale yellowish, in others they have 3 or 4 rings of white, or else white spots on the inner side. The disk is commonly grayish brown, around the mouth, with white radial lines which fork and pass around the bases of the tentacles of the two inner cycles. In some specimens the inner part of the disk is whitish with dark radii, and with the outer part dark brown. In some the disk is nearly all whitish, becoming a little darker near the mouth. The lips are usually whitish or pale yellow; the gullet is white or flesh-color.

The *Actinia paumatensis* Drayton (Dana, U. S. Explor. Exped., Zoophytes, vol. 7, p. 141, 1846; Atlas, pl. 3, fig. 25) somewhat resembles the contracted form of *Macranthea cookei*, but the colors are quite different. The species has an undulated margin and suckers which extend some distance downward as in *Macranthea cookei*. It is also very large and has very numerous tentacles, the inner ones near the mouth. Whether the



tentacles can be withdrawn or the margin unfolded is not stated and its internal structure is not known. Possibly it belongs to the same genus as *Macranthea cookei*. It was from the coral reefs of Raraka Island, Tuamotu Islands.

Type specimen from Laie, Oahu, in the Bernice P. Bishop Museum.

**Anemonia (or Anthea) mutabilis** Verrill, new species (fig. 2, c).

Column smooth, very changeable in form and size; in many specimens shorter than broad, but it may be higher than wide in expansion. In many specimens it is thrown into lobes or folds when low, with the margins of the broad disk strongly waved or lobed, causing the tentacles to appear clustered or tufted. The base in most specimens is wide and adheres closely. Just below the tentacular margin there is a circular row of small, rounded verrucae, closed like the tentacles. The tentacles are numerous, long, slender, tapered, and pointed, usually 90 or more, crowded, not very contractile and not capable of retraction nor of being covered by infolding of the disk margins, but they become short in alcohol.

The general color of the type, in life, was dull or dark olive-green; most of the tentacles were similar in color but paler; proximately they had one or two white bands, and a conspicuous white patch in front of the base, running inward on the disk, which otherwise was olive-green, similar to the column, though paler. Some had the tentacles plain with no white rings but tinged with purple; others had the column and tentacles plain yellowish olive.

Height of column of type in expansion 25 to 40 mm.; breadth about the same. In many specimens the tentacles are 30 to 35 mm. long, and the total breadth 50 mm. or more. One specimen was considerably larger—over 60 mm. in breadth. The mouth and stomodeum are large. When preserved, the mouth in some is broadly expanded, and with the stomodeum partly everted it occupies nearly all of the disk. The musculature of the column wall is rather feeble and diffused. The longitudinal muscles are the stronger. No specialized sphincter muscle could be distinguished. Numerous mesenteries are perfect and most of the larger and many of the smaller ones are fertile. Their musculature is weak. Some of the alcoholic specimens scarcely show the small rounded marginal tubercles or verrucae. Others have them conspicuous and conical or papilliform. They alternate with the outer or marginal tentacles, which are considerably shorter than the rest. There may be 5 or 6 cycles of tentacles on the larger specimens, so that the number may be from 186 to 387. The type was taken from a tank of the Honolulu public aquarium where specimens adhered to the sides, most of them close to the surface of the water.

Type specimen in Bernice P. Bishop Museum.

**NECTOTHELA** Verrill, New Genus

Small, soft, delicate actinians with a rather short, highly muscular, smooth column, very changeable in form; a wide based disk; and very numerous long, slender, unequal tentacles, incapable of involution, but capable of contracting in length. The inner ones are much longer than the marginals. The species lives attached to marine plants, but when disturbed it can swim about like a small jelly-fish by contracting and expanding the muscular disk. There is no definite sphincter muscle. Fertile mesenteries are very numerous.

The tentacles in full expansion are very slender and curve actively in all directions. They are easily detached, by contraction of circular muscles at the base. In the larger specimens they are in 7 to 8 cycles. Therefore they may number upwards of 762—perhaps there may be as many as 1000. They form 6 to 8 rows, covering

much of the disk and crowded at and near the margin. The marginal ones may be less than half as long as the others, when preserved. The tentacles in the 16 preserved specimens examined were neither retracted nor infolded, but were very much decreased in length.

Owing to the softness and delicacy of the tissues, no good sections could be made without a microtome and means of embedding in paraffin. It is evident, however, that it has no definite sphincter muscle, while the general musculature of the column is well developed, in two directions, but diffused, and the disk is also highly contractile. The mesenteries are very numerous and crowded.

It is evident that *Nectothela* is closely related to *Anemonia* (*Anthea* of some authors), the principal differences being the absence of marginal verrucae (or acrorhagi) and the greater number, more slender, and easily detached tentacles, together with its ability to swim actively, owing to its peculiar muscular development.

***Nectothela lilae* Verrill, new species (fig. 2, d-f).**

A small, delicate, and very active species, found attached to the leaves of a marine flowering plant of the genus *Halophila*, growing in tide pools. When detached it is able to swim about, like a small jelly-fish, by contracting and expanding its disk, which is in most specimens contractile. The larger specimens, when living, had bodies 10 to 12 mm. high, and 6 to 10 mm. broad in full expansion, but varying constantly in size and form.

In ordinary expansion the column is short, or only about as high as broad, but it is very changeable, often becoming elongated and slender, like a pedicel for the crown of tentacles, and it is then two or three times as long as broad. It is smooth and lubricous. This species is very soft and delicate, and does not preserve well either in alcohol or formalin. Its remarkable ability in swimming is due to the unusual development of the muscles of the disk and column and perhaps, also, to the motility of the tentacles. In many preserved specimens it is very short, about half as long as high, fan-shaped or lens-shaped, but showing the basal disk. The mouth is small and often has the lips protruded in a short trumpetlike form, and minutely crenulated, with small gonidial grooves. The siphonoglyphs are small. In some specimens a papilliform lobe projects from one of the gonidial grooves. No marginal tubercles or verrucae could be detected. When the mouth is expanded or protruded only a narrow ring of the disk remains visible.

The usual color of the column and disk is pale ochraceous and translucent, but in some specimens flesh-color. The tentacles are commonly pale yellowish, translucent, and crossed by 6 to 8 narrow flake-white lines or rings, but in some specimens these lines are fewer and wider, so that the tentacles appear nearly white, except near the slender tips. Some have the tentacles merely spotted with white. Some have a dark spot at the inner base; others lack it. A few of the tentacles have a lilac tint. The dark spot at the inner base may be very distinct, and divided by a white line, or by one or two spots of white.

The species was first found by Dr. C. Montague Cooke, Jr., in tide pools on a small island opposite his seaside house at Malaekahana on the northern coast of Oahu. It is named in honor of his wife, Lila Lefferts Cooke.

This species somewhat resembles *Paranthea minuta* Verrill from the Bonin Islands (Essex Inst. Proc., vol. 5, p. 322, pl. 1, fig. 4, 1865). In *P. minuta*, however, the tentacles are much fewer and not so long and slender, according to the figure made from life.

Type in the American Museum of Natural History, Cat. No. 1476—Paratypes in the Bernice P. Bishop Museum.

## SAGARTIADAE Gosse

Actinians provided with long, slender, thread-like organs (acontia) covered with microscopic stinging cells (cnidae), which they can project from pores in the sides of the body, either in rows or scattered, and also, when much irritated, from the mouth. In most contracted alcoholic specimens the cnidae are all, or nearly all, ejected and lost. The column is smooth, or bears small adhesive suckers or, in such deep water northern genera as *Actinuga chondractinia* (Subfamily, Chondracxminae), even large thickened tubercles. In some species there is a marginal fold of fosse about the column. In several genera the base surrounds and girdles stalks of Permatulacea and gorgonians.

The tentacles, very numerous in the most of the larger species, can be quickly and completely retracted, involuted and concealed. There is a definite mesodermal sphincter muscle. The six primary pairs of mesenteries are perfect; many of them are sterile, and very muscular. Often twelve or more pairs of mesenteries may be perfect.

Many of the species, for example *Metridium dianthus*, are able to reproduce asexually, either by direct fission or by fragmentation of the margin of the base. Other species reproduce by basal budding. Yet sexual breeding is the rule. Many are viviparous.

The remarkable variations in the internal structure of such genera as *Metridium* and *Sagartia*, is apparently due generally to asexual modes of reproduction. Thus though two siphonoglyphs is the normal condition, some individuals have one, three, or even more, with similar variations in the mesenteries and other organs.

The genera and species of Sagartiadae are very numerous and widely distributed, both in arctic and tropical regions, and from above low tide to great oceanic depths. Some are elongated and live buried in mud or sand with only the disk and tentacles exposed. Many are associated as commensals with crabs and hermit-crabs. In particular, *Calliactis* and *Adamsia*, and some species of *Sagartia*, nearly always live attached to the shells occupied by hermit crabs on all the warmer seas. Most species of *Calliactis tricolor* in the seas of Florida and the West Indies live on large shells occupied by a hermit-crab but some live in groups attached directly to the back or to the legs of the large spider crab, *Macrocoeloma cornuta*. The back may be entirely covered with them.

A species in the China Sea, *Sagartia paguti* Verrill (Essex Inst., Proc., vol. 6, p. 23, 1869) lives on a smooth round spot provided for it on the larger claw of a hermit crab. When the crab retracts, it seems to emerge from the aperture of the shell and conceals as well as protects the crab. The species *Sagartia carcinophila* Verrill (Connecticut Acad. Sci., Trans.,

vol. 1, pt. 2, p. 484, 1869) lives attached directly to the back of a small crab (*Hepatella amica*) in the Bay of Panama. A species of *Adamsia* in European seas attaches itself for life to univalve shells occupied by hermit crabs. It is a low-growing form with a wide base that spreads around the aperture of the shell and then unites in an annular form which secretes a horn-like pelicle that extends the edges of the aperture, so that the crab never needs to change the shell as it grows larger. This is also done by various species of *Epizoanthus* that live on shells of hermit crabs, especially in the deep seas. Some have the power of completely dissolving the occupied shell, later in life, thus making more room for the crab and save moving.

The species *Sagartia consors* Verrill (Am. Journ. Sci., vol. 23, p. 225, 1882, as *Urticina*), a large, handsome, bright red species, lives in the Gulf Stream at depths of 160 to 458 fathoms. It lives on shells occupied by a peculiar deep-sea hermit crab, *Parapagurus pilossimanus*.

The species *Sagartia sociabilis* Verrill (Am. Journ. Sci., vol. 23, p. 225, 1882, as *Adamsia*), lives attached to the under side of small pteropod shells, occupied by another deep-sea crab from the same region. It is in such a position as to bring its mouth close to that of the crab, thus making sure of a fair share of food.

The large species *Carcinophila expansa* Verrill, from the China Sea, lives on the back of a regular lively crab (*Dorippe*). This actinian, unlike most others, secretes a thin, horn-like plate on its base, and the crab holds the actinian on its back by means of this plate, which it grasps by the edges with the claws of its hind legs, which permanently turn up over its back for this purpose.

All these species illustrate and demonstrate the "inheritance of acquired characters," for all live as free-swimming larvae for some time, and adopt these actinians after they go to the bottom and need their defense. They know enough to find and transplant them to their own shells when young and to transfer them to their new shells when they have to change or moult. Moreover, they select actinians of this family, for these have more powerful stinging organs than any others.

***Sagartia pusilla* Verrill, new species (fig. 2, *g, h*).**

A small, plain, delicate species very changeable in form. The column is smooth, in full expansion it may be cylindric, or hourglass shape with a waistlike constriction and enlarged at one or both ends, or swollen in the middle or at or near the base. In contraction it can become a low cone or hemisphere, or even button-shaped, with the tentacles entirely retracted. The pores for the slender acontia are minute and scattered. Few acontia were seen protruded and then only when irritated. The tentacles are very slender and acute or obtuse; the longer 12 inner ones are two or three times as long as the diameter of the disk or column. Others are very unequal

in length, the outer ones being much the shorter, about one-fourth the length of the inner ones. There are usually 24 to 48, rarely 60 or more. Young *pusilla* were found with only 12 to 18 tentacles associated with the larger ones. These were only 3 to 4 mm. high and 0.5 to 1 mm. broad. The larger ones were 6 to 10 mm. high in expansion and about 2 to 3 mm. broad; most were only 4 to 6 mm. high and 1 to 2 mm. broad.

In most specimens the column is flesh color, but in some the columns are pale orange or pink, or pale greenish when on green *Ulva*. The tentacles are usually paler, sometimes darker, translucent, flesh color or pale brownish orange, spotted or crossed with whitish dots, markings or rings, especially at the inner base; the white lines may run to the lips as radii. The young ones were similar in color but paler, with faint flake-white specks at inner bases of tentacles; darker outside. This species occurs on the sides and bottom of lava beach stones, in clusters, singly in small holes and cracks, from which it is hard to remove it; also green *Ulva* and shells. It is very sensitive and soft, and contracts quickly. In dishes it moves about freely and eats readily. Some will detach themselves and float at the surface well expanded. In the sea on stones the base of many specimens is covered with mucus and adherent mud, for it secretes abundant mucus.

To the naked eye most individuals closely match the color of the stones to which they are attached. A few had a flesh-colored body with greenish brown tentacles and disk. Others had a green body and flesh-colored tentacles. Some had pale tentacles with a dark central line; others pale tentacles with a pale central line. In some the inner bases of the 12 inner tentacles have a V-shaped white basal marking which runs into the lips as white radial lines; some have about 6 faint white rings on the tentacles. Some by transmitted light have the tentacles tinted with lilac or pale purple. In many specimens the mesenterial lines and stomach show by translucency.

The species was found at and above low tide up to about half tide on the shore of Nawiliwili Bay, near its inner end and near the bridge, associated with *Spirorbis*, *Neritina neglecta* and green *Ulva*, where the water is somewhat brackish.

Type from Nawiliwili Bay, Kauai, in American Museum of Natural History, Cat. No. 1479. Paratype in Bernice B. Bishop Museum.

### **Sagartia longa** Verrill, new species (fig. 2, i).

The column, as preserved, is elongated and clavate, with the base wider than the column adjacent. Its surface is finely wrinkled in both directions, indicating that in life the form was unusually elongated. The wall is rather thin and soft, with no tubercles or suckers visible; musculature is diffuse. Cinclidae are not positively distinct, but appear to be minute and scattered. Acontia were numerous in the sectioned specimen. There is no very distinct sphincter muscle. The subtentacular margin is thin and acute.

The tentacles, as contracted, are short and thick, their tips visible. They number about 24, in 3 cycles, the 12 inner ones much larger than the outer ones. In a section, the perfect mesenteries of the first and second cycles are strong with thick muscles, and all except the directives bear gonads; those of the third cycle are narrow and

imperfect, but bear small gonads, toward the base. The color in life was not noted. Length, as contracted, about 25 mm.; diameter distally 8 to 10 mm.

Type specimen from Christmas Island, Pacific Ocean, in Bernice P. Bishop Museum. Other specimens were taken from Oahu.

**Sagartia pugnax** Verrill, new species (Pl. III, B, IV, A; fig. 2, j).

A small plain appearing actinian—a normal *Sagartia*.

The column is cylindric and so far as could be learned from alcoholic specimens its surface is smooth. No pores could be seen but acontia were found inside or partly emitted. In the preserved specimens studied which may not be adult, the tentacles are slender, about 24 to 36 in number, nearly equal in size, and rather longer than the diameter of the column, which is about 5 mm. The height of the column is 6 to 7 mm.

The color in life, according to photographs made by Prof. C. H. Edmondson, from living specimens at Honolulu, is pale green.

This species is carried about as a commensal, firmly held in both claws (chela) of two very different appearing small crabs, *Lybia* (*Melia*) *tesselata* and *Polydectus cupulifera*. They are kept by the crabs for defensive use, serving as protective living shields, against fishes and perhaps other enemies which fear the poisonous stings of the actinian tentacles and acontia. On the other hand the actinians are in position to get a share of the food that the crabs capture.

Borrodaile (Fauna and Geog. of the Maldives and Laccadive Archipelagoes, vol. 1, p. 250, fig. 49, 1903) states that while the crab holds the actinians he cannot use the chela for feeding, but instead uses the outer maxillipeds for that purpose. He also states that when the actinians are removed the crab immediately picks them up again. Edmondson observed the same conduct, with *Melia* and also with *Polydectus*.

He found that when actinians of the species *Tealiopsis nigrescens*, very different in color and appearance, were provided, the crab immediately seized them and carried them about even when very much too large for him. (See Pl. V, A.)

The legs and the carapace of *Polydectus* are densely clothed with hairs, to which mud adheres, thus concealing the form of the crab. Its chela appear to be specially modified in structure and the denticles of the claws have become sharp for this particular use. On the contrary the legs of *Lybia tessellata* are long, slender, not hairy, and the legs and carapace are conspicuously colored. Borrodaile found this species living among the branches of corals. Its pale legs are long, slender and conspicuously banded with bright purple rings, while the back of its carapace is regularly veined and reticulated with purple lines, leaving angular or irregular areas of various sizes, colored pink, brownish-yellow, or greenish. Its colors are not at all protective, for the carrying of its actinian shields renders protective colors unnecessary, and perhaps its legs and hinder parts are well protected by the stinging organs of the coral polyps.

The species of *Polydectus* lives under the edges of stones in shallow water and is protected by its mud-colored hairy body and short hairy legs covered with mud, making it look like a lump of mud, except for the actinians.

This actinian, *Sagartia pugnax*, like both its commensal crabs seems to have a wide range in the Pacific islands and the Indo-Pacific generally. The type is from Oahu, on the claws of *Lybia*, collected and photographed from life by Professor C. H. Edmondson.

Specimens of this actinian associated with *Lybia* and *Polydectus* from the Hawaiian islands, Palmyra, Washington, Christmas, and Howland islands, are in the Bishop Museum.

When the crab sheds its shell it must have intelligence enough to remove and transplant the actinian to its new claws, but I do not know that anyone has seen this operation. It is also remarkable that the crabs have intelligently selected members of this family, which are the only ones that have stinging threads or acontia, which are the most efficient organs for this purpose found in actinians.

This habit is a notable instance of the "inheritance of acquired characters," for these crabs live for some time in the free-swimming (Zoea) larval forms, with no such habits, and assume the habit of carrying the actinians only after moulting into the crab form and going to the bottom, a habit inherited, of course, from their remote ancestors, who must have learned them by trials and experience, when past the larval stages.

The peculiar alterations in the claws for this use is also an example of inheritance, and also of the Lamarckian theory of the effects of use on structures; and especially of the Darwinian doctrine of "natural selection," or survival of the best fitted. Those that do not find and carry the actinians are probably eaten by fishes, while very young.

#### Genus *CALLIACTIS* Verrill, 1869

*Cribrina (pars)* Ehrenberg, 1834 (*non* McMurrick).

*Calliactis* Verrill: Connecticut Acad. Sci., Trans., vol. 1, pt. 2, p. 481, 1869.

The species of this genus have the lateral pores for the acontia arranged in one or more transverse rows near the enlarged or broad base. Many of these pores have raised margins and are conspicuous. Nearly all the species live attached to spiral gastropod shells occupied by hermit crabs, singly or in clusters. When the crab removes to another larger shell he picks up and places the actinians on his newly occupied shell. The acontia are numerous,

long and slender, readily emitted, and carry vast numbers of stinging cells. ***Calliactis armillatas*** Verrill, new species (Pl. IV, B).

In full expansion, the column may be nearly cylindrical or somewhat hour-glass shaped, with a wider and expanded thin-edged base, attached to a spiral shell occupied by a large hermit crab, *Dardanus asper*, so far as observed. Commonly several occur on the same shell, and they may often be sufficient in number to entirely cover it with their bases. The height of most specimens is equal to the diameter of the column in expansion, but many are considerably higher. In strong contraction, it forms a low rounded or flattened cone. The tentacles are numerous, long, slender, tapered to the tips, changing rapidly in size and form, very contractile, in full expansion usually considerably longer than the diameter of the column. They number as many as 200 or more.

The column in expansion is nearly smooth, except for the pores or cinclidae, which are conspicuous in one irregular or two alternating transverse rows near the base. Many of them have slightly raised light colored borders. Many mesenteries show through the walls as light longitudinal lines in full expansion, especially near the base. The color is quite variable, as in most species of the same genus; but is not so bright as in several other species. The common color of the column is deep yellowish brown or orange-brown, more or less blotched or mottled with dark red or dull brown; below the cinclidae are pale or white longitudinal lines, due to the mesenteries. Some are faintly or strongly shaded with violet or pale purple; in most specimens the cinclidae have pale or white borders.

The tentacles are commonly pale yellowish or light ochraceous; some are more decidedly yellow or yellowish brown or purplish. In nearly all specimens the tentacles are annulated with 10 or more narrow white lines or rings (hence the name *armillatus*, ringed) and there is a spot of flake-white both at the inner and outer side of the base.

The disk is commonly pale buff or brownish yellow, or tinged with purple or orange; many individuals have about 12 flake-white spots on the lips. One specimen has a ring of yellow close to the upper margin of the column, below the bases of the tentacles. Height of column, 30 to 40 mm.; diameter in expansion 25 to 30 mm.

Described from living specimens in the aquarium in Honolulu and from others collected on the coral reefs of Oahu by Mr. T. T. Dranga. Others in alcohol from Laysan Island in Bernice P. Bishop Museum were used for anatomical study.

Young living specimens photographed by Professor Edmondson are shown in Plate IV, B.

The larger alcoholic specimens from Laysan Island, collected by S. C. Ball, have two irregularly alternating transverse rows of cinclidae, with about 48 in each row. As there are 6 to 8 mesenterial lines between each 2 of the cinclidae of a row; the total number of tentacles is probably 250 or more. The acontia are long, slender, and very numerous.

In sections, the sphincter muscle is seen to be well developed, roundish or a little ovate. The 2 directive pairs of mesenteries are strong, muscular, but one pair is distinctly the thicker. The first 4 cycles of mesenteries, except the directives, are fertile, as well as many of the others. The 2 gonidial grooves are conspicuous.



A group of about half-grown specimens from the Oahu reefs consists of 3 larger ones on a shell of *Turbo intercostalis*, and 2 smaller ones, of which 1 is on the columnella and partly extending inside of the lip, while the other is on the outer lip at the edge. A very young one, with 24 tentacles, is also on the outer lip. The one on the columnella has at the edge of its expanded base 7 minute young ones, 0.5 to 1 mm. in diameter, with about 12 tentacles, which have originated as buds from the basal margin; some are not yet entirely separated. One of the larger ones has the margin of its base extending beyond the edge of the aperture of the shell, and then revolute.

This species is, perhaps, most nearly allied to *Calliactis sinensis* Verrill, from near Hong Kong, China (*Cereus sinensis*, Essex Inst., Salem, Proc., vol. 6, p. 54, 1869) but the coloration is quite different. The type of *Cereus sinensis* has 12 stripes of purple on the column and the tentacles have 6 bands of purple on a yellow ground color.

In form, habits, and general structure this species also resembles *C. decorata* Drayton (Dana, U. S. Expl. Exped., Zoophytes, p. 139, color plate 3, fig. 24, 1846), the type of the genus, from Honden Island, but the colors are very different.

Another allied species is *C. variegata* Verrill, from Panama (op. cit. 1869, p. 181), a large species attached to shells occupied by hermit crabs. The colors of *variegata* are, however, much brighter and very different in pattern.

Specimens from Laysan Island in Bernice P. Bishop Museum. (The specimens photographed and the living specimens from which Mr. Verrill made studies were not preserved. C. H. E.)

### Genus PHELLIA Gosse

Sagartians in which the column is covered by a closely adherent coating of mud and sand, not detachable. Otherwise nearly like *Sagartia*.

**Phellia humilis** Verrill, new species (fig. 2, *k*).

A small species, so far as observed. When expanded in life it was 8 to 10 mm. high and 1.5 to 2 mm. in diameter.

The column is covered nearly all over, except close to the pale whitish, distal margin, with a firmly adherent coating of sand and mud, dark, or even blackish in color in those obtained.

The tentacles are slender, apparently 24, about as long as the diameter of the disk when expanded, translucent whitish or pale flesh-color with narrow linear annulations of brown. Some specimens show small flake-white spots on the tentacles and when the coating is thin, 12 slight grooves and longitudinal ridges can be seen on the upper part.

Several occurred adhering to stones by a narrow base at low tide on the shore of Nawiliwili Bay, January 7, 1926. It is easily detached.

(Type of this species has not been located. Field number 69 was apparently not deposited with the American Museum of Natural History or in the Bernice P. Bishop Museum. The illustration is from Mr. Verrill's original drawing. C. H. E.)

#### Family ALICIADAE

Actinians, many of them large, with soft, not very muscular columnar walls and long tentacles, not very contractile. No definite sphincter muscle.

Exterior of the column usually bears many rows of more or less elevated verrucae; hollow and not adapted for adhesion. The upper ones may be more elongated or even branched.

#### CLADACTELLA Verrill, New Genus

Aliciadae with rows of round or elliptical low verrucae on the column. Tentacles of moderate length, numerous, somewhat contractile, but not involuable.

**Cladactella manni** Verrill, new species (Pl. IV, C; fig. 3, *a-c*).

*Bunodactis manni* Verrill: Am. Jour. Sci., vol. 7, p. 218, 1899.

The best specimen seen alive was found November 26, 1924 on the side of a boulder at extreme low tide on the shore of Nawiliwili Bay, Kauai.

In full expansion, the column is about 25 mm. high and 25 mm. in diameter; the breadth of the expanded crown of tentacles, about 40 mm.; length of longer tentacles, 12 mm. or more; their diameter, at the base of the largest, about 1 mm. The column is nearly cylindrical, and entirely covered with numerous longitudinal rows of crowded, smooth, roundish or elliptical low verrucae, which seem unadapted for adhesion and are all nearly equal in size. Many of them show longitudinal lines when thin. In number the rows appear the same as the tentacles, about 72.

The tentacles are moderately stout at the base and taper regularly to the blunt or acute tips, and seem only little contractile, even when put in formalin. They form about 4 rather indistinct rows. The outer ones are not much shorter than the inner ones.

The mouth is large when expanded, with a large siphonoglyph at each end, bordered by a large lobe on each side; the lips have also 6 lobes on each side; the lobes next to those of the siphonoglyphal grooves are larger than the 4 intermediate ones.

In life the color of the column is dull dark green; its base orange; the tentacles brownish purple, becoming light purple toward the tip; in partial contraction becoming darker or dusky brown; disk dark purple or brownish; lips lighter purple.

The largest and best preserved specimen has about 96 tentacles, belonging to five cycles, and apparently also a few of the sixth cycle. The outer ones, as preserved are not much shorter than the others. There are about 96 pairs of mesen-

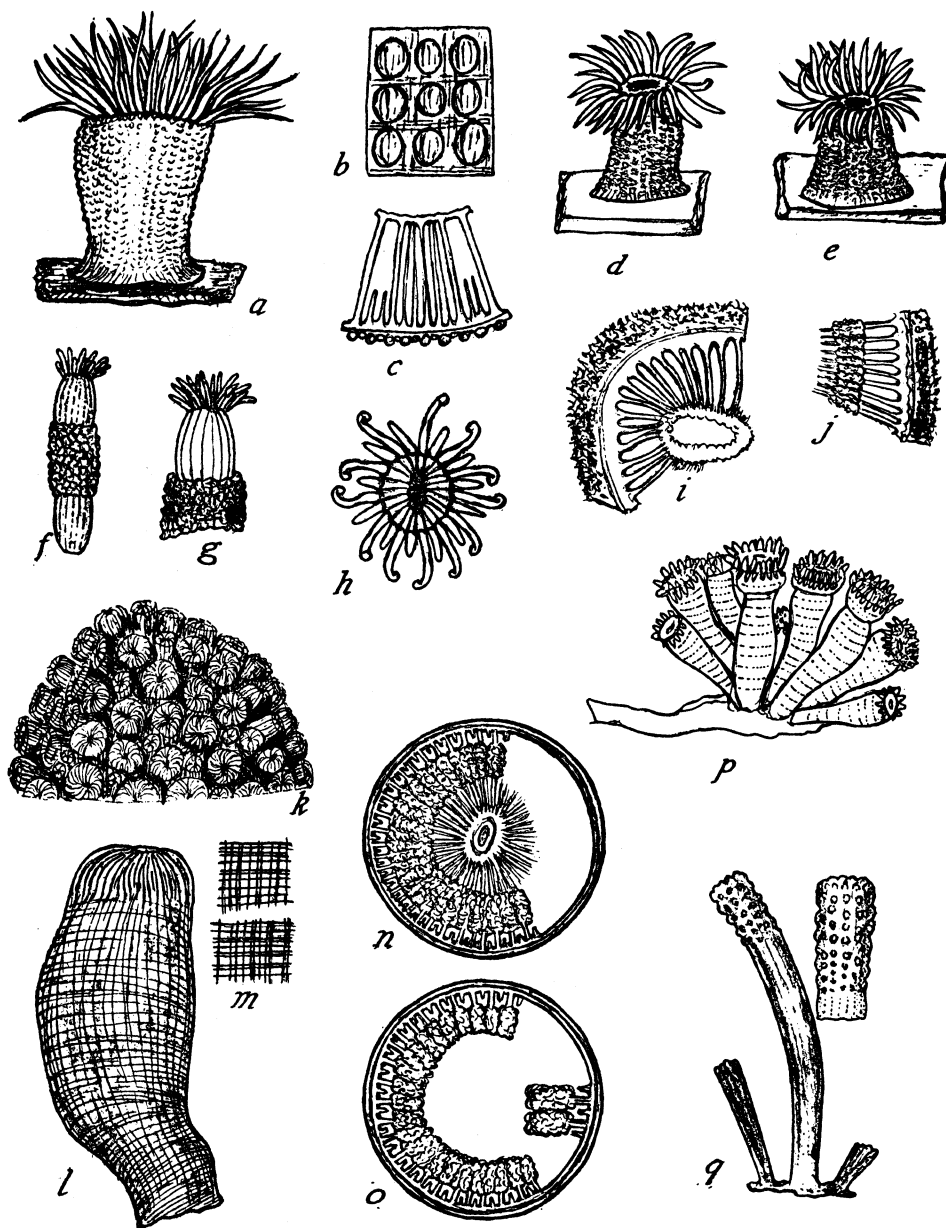


FIGURE 3.—a-c, *Cladactella manni* Verrill: a, expanded showing surface covered by verrucae (natural size), b, enlarged area of surface of body wall showing linear arrangement of verrucae, c, cross section of wall and mesenteries ( $\times 2$ ); d-e, *Cladactella obscura* Verrill, two specimens in expanded condition (natural size); f-h, *Edwardsiella carneola* Verrill: f, entire specimen expanded, showing coating of foreign material ( $\times 2$ ), g, distal half of the same specimen ( $\times 4$ ); h, oral view of same specimen ( $\times 8$ ); i-j, *Zoanthus vestitus*: i, transverse section through region of gullet ( $\times 8$ ), j, transverse section below gullet, showing mesenteries bearing gonads; k-o, *Zoanthus confertus*: k, colony of contracted polyps (slightly enlarged), l, contracted polyp ( $\times 4$ ), m, two small areas of body surface ( $\times 4$ ), n, o, transverse sections of polyp showing numerous mesenteries bearing gonads ( $\times 5$ ); p, *Zoanthus nitidus* Verrill, a group of expanded polyps attached to a stolon ( $\times 2$ ); q, *Isaurus elongatus*, three partially expanded polyps, young and old with distal portion of one more enlarged from one-half to natural size.

teries, all perfect except a few of the fifth cycle, nearly all have small gonads toward the inner edge. All are very thin, with no prominent musculature.

The wall is thin with feeble musculature, quite to the bases of the tentacles. The mouth has deep gonidial grooves, bordered by thickened lobes; sides of lips have numerous small lobes, 12 or more on each side.

In transverse sections the specimen figured had 48 pairs of perfect mesenteries, generally with two narrow imperfect mesenteries of the fifth cycle between each pair of perfect ones. All the mesenteries are thin with feeble musculature; but the directives are more muscular than the rest.

Very few gonads were present in the specimens examined. Those seen are small and nearly all borne on the narrow, imperfect mesenteries. The wall of the column is thin with a weak, diffuse musculature. There is no distinct sphincter muscle. The external verrucae are hollow and communicate with the interseptal cavities by narrow necks.

The verrucae next to the tentacular margin are somewhat larger and more prominent than those below, of the same row, but smaller ones alternate with the larger ones. In the contracted condition of the preserved specimen, most of the verrucae are nearly or quite in contact, in both directions, and generally have a somewhat elliptical outline and convex surface which is usually marked with 3 to 5 (generally 4) narrow raised lines and distinct grooves. (See figure 3, *b*.)

When the specimen was handled the column did not contract much, the tentacles did not withdraw but contracted considerably. When put in formalin it contracted to about one-half its original size, but the tentacles were not retracted.

According to the original description the type was larger: "Height in expansion 25-50 mm., diameter of disk 25 mm. or more." The color was as follows: "Column usually dark green; verrucae dark red or brown; disk, around the mouth, pink or light red; tentacles dark red."

The original type was from the coral reefs of Oahu, probably collected by Horace Mann, in whose honor it was named. He was one of my fellow-students in Harvard University, and visited Hawaii about 1866, making large collections of the plants, corals, and other specimens. He died young, before his work on them was finished.

Type specimen in American Museum of Natural History, Catalog No. 1493.

***Cladactella obscura* Verrill, new species (Pl. IV, *D*, *E*; fig. 3, *d-e*).**

Column usually short and cylindrical in expansion, but changeable; covered with numerous, close, regular longitudinal rows of simple rounded verrucae, not very unequal in size or form, and colored like the rest of the column, apparently not used for attaching foreign substances; the marginal ones are not much enlarged. The tentacles are long, moderately slender and usually pointed, contractile, but apparently not often, if ever, retracted. The type specimen, which may be young, has about 40 to 48 tentacles, when the column in life is 10 to 12 mm. in height and about the same in breadth (height of column in some specimens is 14 to 16 mm. in expansion). The color of the column in life is commonly purplish brown or dark brown; disk usually smoky brown; tentacles commonly dull, dark, greenish gray, with pale tips and a slender line of white on each side; some are yellowish or tinged with orange.

In sections, the musculature of the thin walls seems feeble and diffuse, with no specialized sphincter; many mesenteries are perfect and bear gonads, though these were probably from immature specimens.

The type was found in the tanks of the Honolulu aquarium and paratypes were collected in the water conduits running from the tanks. Others were taken in Pearl Harbor, in 6 to 8 feet of water, by Mr. T. T. Dranga.

Type specimen in the American Museum of Natural History, Catalog No. 1484. Paratypes in Bernice P. Bishop Museum.

Family URTICINIDAE Verrill, 1922

*Bunodidae* (*pars*) Gosse: Ann. and Mag. Nat. Hist., 3rd ser., vol 1, p. 417, 1858.

*Bunodactidae* Verrill: Am. Journ. Sci., vol 7, p. 216, 1899.

*Urticinidae* Verrill: Report on the Actinaria of the Canadian Arctic Exped., vol. 8, pt. G, p. 103, 1922.

Actinians with a well-developed or prominent, circumscribed endodermal sphincter muscle, and therefore able to retract and involute the disk and tentacles. The column is usually covered more or less with longitudinal rows of raised concave verrucae or suckers, capable of attaching grains of sand, and fragments of shells. The tentacles are usually rather stout, numerous, and strongly muscular and retractile. In most specimens many of the mesenteries are fertile, except the smallest and their muscles are thickened; the basal disk is broad, for adhesion. No acontia.

In some specimens the tentacles and mesenteries are decamerous, in multiples of 5 instead of 6, the normal number. This arrangement characterises many of the large northern *Urticina crassicornis*. (See Verrill, A. E., Rept. Canadian Arctic Expedition, vol. 8, pt. G, pl. 19; fig. 4, p. 140, 1922.) Some genera carry their eggs and young embedded in the external layer of the column walls. Others are viviparous. (See *Pseudophellia arctica* Verrill of the North Pacific coast, and *Epigonactis* from N. Atlantic, Canadian Arctic Exped., vol. 8, pt. G, pp. 114, 115, 1922.)

Genus TEALIOPSIS Danielssen, 1890.

*Bunodes* Gosse: Linnean Soc., Trans., vol. 21, p. 274, 1855. (The name was preoccupied for a fossil in 1853.)

*Bunodactis* Verrill: Am. Jour. Sci., vol. 7, pp. 42, 43, 1899.

*Tealiopsis* Verrill: Rept. Canadian Arctic Exped., vol. 7, pt. G, pp. 110 to 112, 1922 (where its history is fully given).

**Tealiopsis nigrescens** Verrill, new species (Pl. V, A, B).

Column usually nearly cylindric, often not much higher than broad, but changeable. Covered with regular rows of rather large, conspicuous, raised verruciform suckers, capable of firmly attaching to such objects as grains of sand and pieces of shells. The rows are the same as the number of tentacles and extend nearly or quite to the base. They are not crowded; those in alternate rows are larger and smaller; the uppermost one particularly enlarged. The tentacles are rather stout, of moderate length, tapered regularly, length greater than the diameter of the disk. As counted, the tentacles number about 48 to 60, but these specimens are probably immature. The number in mature ones may be 96.

In sections, there is a definite endodermal sphincter muscle; and numerous perfect mesenteries, most of them fertile.

The color of the column is very dark or smoky brown, or nearly black. Many verrucae are paler in the center. The tentacles are lighter brown than the body and some have a purple tint, without conspicuous markings.

The larger specimens found were only 10 to 15 mm. high and 10 to 12 mm. broad, in expansion. The type was from the shore of Nawilwili Bay, Kauai, at low tide in a tide pool or under a stone. Two others came from the sides of an old scow, near the breakwater, March, 1925.

Type specimen in the American Museum of Natural History, Catalog No. 1485.

Family EDWARDSIDAE Andres, 1884, emended.

The family Edwardsidae includes singular small, slender actinians, usually living buried in mud, sand, under stones, or in other holes, with only the tentacles exposed. The body usually has the middle region thickened and covered with closely adherent mud or sand (rarely naked as in *Drillactis* Verrill, 1922), and rather firmer than elsewhere, while the basal and distal areas are naked, smooth and in many specimens translucent enough to show the mesenterial lines within. There is no special basal disk for adhesion. The basal end is usually more or less pointed, but is changeable in form. The naked areas can contract into the thicker region.

In most specimens the tentacles are small and few, commonly 16, up to 24 or 36, rarely 48. They may be short or elongated and slender.

One New England species, *Edwardsia leidy* Verrill, while young, lives as a parasite in the Ctenophore, *Mnemiopsis leidy*, until 25 to 35 mm. or more long. In that stage it is naked, pink, and has no tentacles. Later it develops further in the mud of the bottom. It has only been seen young. It was raised in aquaria until 16 small tentacles were developed. It may be the young of *Drillactis* Verrill. The mesenteries in the species are usually few, and not in regular rows. They have strong longitudinal muscles. When the tentacles are retracted some species resemble worms.

## Genus EDWARDSIELLA Andres, 1884.

Distinguished from *Edwardsia* by having more than 16 tentacles. Otherwise very similar.

**Edwardsiella carneola** Verrill, new species (fig. 3, f-h).

A small, pale or light flesh-colored species living in sand or gravel, usually under boulders, at or near low tide mark. It is capable of adhering lightly to pebbles by its basal end, although there is no definite basal disk. When removed, the base is convex or obtusely pointed, but is changeable.

The column is slender, cylindrical, or somewhat swollen in the middle region, which has minute verrucae and is covered with a thin layer of closely adherent fine sand or mud, which may occupy more than a third of the entire length. In most specimens the naked translucent basal portion is more slender and is about two-thirds as long; the contractile distal naked area is shorter, and shows pale mesenterial lines by translucency.

The tentacles are 24, in two regular cycles, larger and smaller alternating. The smaller are about one-half as long as the others, which, in full extension, are about as long as the diameter of the column, slender, not much tapered, with the tips obtuse.

In general the naked parts of the column and of the tentacles are light flesh-color or pale ochraceous. In some specimens nearly white or colorless. Many of the longer tentacles have two partial bands of brown; one near the middle, the other near the base, widest laterally, so that, seen from the front, they are hourglass shaped. The disk is small and pale, in many specimens marked with a six-rayed spot of brown, or with brown radial lines.

Length of the column is 12 to 18 mm.; diameter, 2 to 3.5 mm.; length of the longer tentacles, about 3.5 mm. Perhaps these are not fully grown.

The types were taken from sand under small boulders on the shores of Nawiliwili Bay, Kauai; Nov., 1924, and April, 1925.

Type in American Museum of Natural History, Catalog No. 1482. Paratypes in the Bernice P. Bishop Museum.

## Family ZOANTHIDAE

Compound actinians that increase by budding from a basal coenenchyma, from stolons, or from the sides of the column. Thus they form open clusters or compact clusters, united only at their bases, or combined into compact groups, many of large extent, but of no great thickness, in coral seas. Some species are found only on shells occupied by hermit crabs, especially in the deep sea. They live as commensals with the crabs, and as they grow as fast as the crabs, they extend the cavity and may absorb the shell entirely. Thus the crab does not have to seek a larger shell as he grows.

There is no basal disk; these actinians live permanently attached to some object, even if only a sand grain. The tissues in general are rather firm, though some are soft and smooth, but most individuals attach them-

selves to fine sand which becomes imbedded in the tissues, giving greater firmness and thickness.

The tentacles are generally short and numerous. They and the pairs of mesenteries do not arise in regular cycles of 6 or its multiples, but in pairs so that the number is usually not a multiple of 6 or 12. In many specimens the tentacles are in two rows, alternating in size or position. Apparently all the species are able to contract and infold the distal end of the column with the disk and tentacles; and most are reluctant to expand in confinement.

### Genus ZOANTHUS

Polyps usually partially or wholly free, except at and near the base, without a thick coenenchyma. They arise either as basal buds or from stolons, or membranous expansions encrusting stones.

Tentacles numerous and short, in double rows, mesenteries in many pairs, alternately unequal in size.

#### ***Zoanthus vestitus* Verrill, new species (Pl. V, *D*; fig. 3 *i, j*).**

Forms rather irregular groups of short cylindrical polyps united at and near their bases by a membranous coenenchyma. They stand pretty closely together, nearly parallel, but usually not in close contact while living. The groups may be 50 mm. or more broad.

The column is cylindrical, or slightly enlarged distally, about 20 to 25 mm. high and 4 to 6 mm. in diameter when living. Some are longer and many are smaller. The column walls are rather thick and somewhat rigid. The surface is rough and more or less thickly covered with closely adherent grains of fine sand. The summit, as contracted, is rounded and shows many small convergent unequal ridges and grooves. The tentacles were not seen expanded. The color in life is grayish brown.

The types were taken by Dr. C. Montague Cooke, Jr., in tide pools on a small island off the beach at Malaekahana, on the north coast of Oahu. Other specimens were from the coral reefs off Oahu and Maui.

Type in American Museum of Natural History, Catalog No. 1478. Paratypes in Bernice P. Bishop Museum.

#### ***Zoanthus confertus* Verrill, new species (Plate V, *C*; fig. 3, *k-o*).**

A nearly smooth species that forms crowded or compact groups or masses, 25 to 40 mm. in diameter and up to 20 to 35 mm. or more thick; polyps are so crowded that in alcoholic specimens they may become more or less polygonal; but normally they are cylindric. Small young ones are scattered between the old ones. Diameter of mature polyps is 5 to 9 mm.; height, as contracted, about 12 mm. or more.

Column is nearly smooth, except for slight wrinkles. At the involuted summit are numerous fine convergent sulci, due to contraction. Those less contracted are smooth at the rounded summit that may show an aperture. Color of recently pre-



served colonies is dull grayish green. Sand is not attached, or at least very sparingly on the basal part.

Mesenteries are 48 to 56, as counted in the larger specimens; all are perfect and bear gonads in the stomodial region. Below this the alterant ones are narrow and barren.

The tentacles are 48 to 56, very small, short and slender as contracted. The walls are rather thick, but soft, many with conspicuous lines or wrinkles due to contraction, especially distally.

The type was taken on the reefs of Kalepolepo, Maui, by Mr. T. T. Dranga. Type specimen in American Museum of Natural History, Catalog No. 1489. Paratypes in Bernice P. Bishop Museum.

**Zoanthus nitidus** Verrill, new species (fig. 3, *p*).

A small species that forms small divergent clusters consisting of 3 or 4 to 8 or more polyps, united together at their bases, or arising close together from a thin, basal, encrusting membrane. Each larger cluster may send out stolons from which newer clusters arise, consisting at first of only 2 or 3; some young polyps stand free and singly on the stolons. Buds also arise from near the bases of older ones. The more mature polyps vary much in form in the preserved specimens and nearly all show the tentacles partially contracted.

The column walls are nearly smooth, except for transverse wrinkles due to strong contraction. Some have a deep constriction just below the tentacular margin. They may be cylindric, vase-shaped with the lower part swollen, or more or less club-shaped; or they may be swollen in the middle. Probably in life they were relatively taller.

In the preserved specimens the larger polyps are 10 to 12 mm. high and 3 to 4 mm. in diameter, most of them about 3 mm. Height of the largest cluster, 15 mm.

The tentacles, as preserved, are crowded, small and numerous. About 60 were counted in some of the larger polyps. There may be more for they are hard to count. They seem to be in 4 rows. The larger ones are about half as long as the diameter of the disk, as preserved. They are tapered, sub-acute.

As preserved, the general color is dark, dull green. In life the upper portion is bright green.

Taken on the coral reefs at Waikiki, near Honolulu.

Type specimen in American Museum of Natural History. Paratypes in Bernice P. Bishop Museum.

Genus **ISAURUS** J. E. Gray

Zoanthids that may stand singly (perhaps only when young), but usually form open groups of different sizes of polyps which arise as buds from stolons. The body is usually elongated and somewhat club-shaped, being enlarged distally. The integument is firm and distally it forms stiff, raised, wartlike or crest-like or conical thickened elevations.

The tentacles are numerous and variable in number.

**Isaurus elongatus** Verrill, new species (Pl. V, *E*, *F*; fig. 3, *q*).

The column is cylindrical or slightly clavate, many 60 to 70 mm. high and 5 to 7 mm. in diameter, and rather rigid.

Two or more individuals may be united by slender basal stolons. A large one connected to two or more small ones, of different sizes (a young one was 25 mm. high and 5 mm. broad, in life). The upper part of the column is covered with small, hard conical or irregular raised verrucae, in vertical rows; the upper ones are the larger; below these it is smooth and naked. The verrucae extend downward for about one-fifth the length of the column; below this the mesenterial lines show through. The summit, in contraction, is involuted and shows about twelve rounded irregular verrucae or ridges separated by strong grooves. The tentacles were not seen expanded in life.

The color of the column is brownish green or dark olive-green, darker distally.

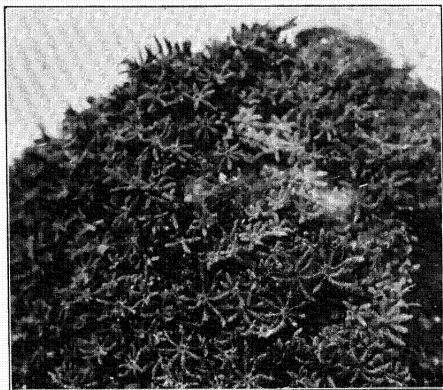
Many of the mesenterial lines show through faintly as darker lines; as many as 24 may be visible, not crowded together.

The types were associated with *Zoanthus vestitus* in tide pools on a small island at Malaekahana, Oahu. They were collected by Dr. C. Montague Cooke, Jr. Others are from Pearl Harbor, in 6 to 8 feet of water, collected by Mr. T. T. Dranga. It has also been taken from the Kaaawa reefs, windward Oahu.

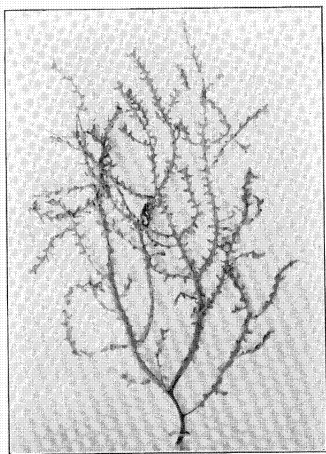
Type in the American Museum of Natural History, Catalog No. 1488. Other specimens are in Bernice P. Bishop Museum.





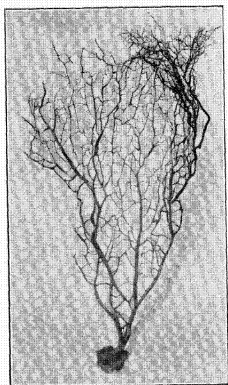


*A*

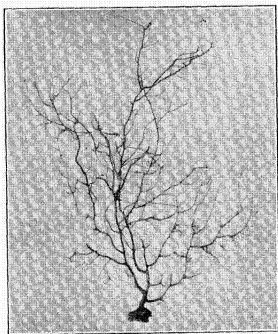


*B*

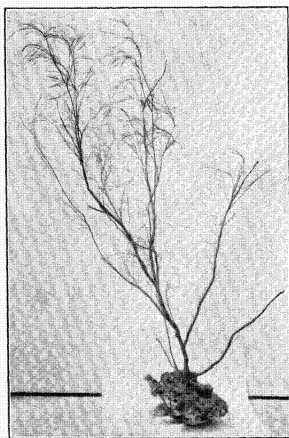
*A*, *SARCOThELIA EDMONDSONI* VERRILL, NEW SPECIES, PHOTOGRAPH OF LIVING SPECIMEN ( $\times 2$ ); *B*, *ALLOGORGIA EXSERTA* VERRILL, NEW SPECIES, PHOTOGRAPH OF DRIED SPECIMEN  $\frac{3}{4}$  NATURAL SIZE.



A

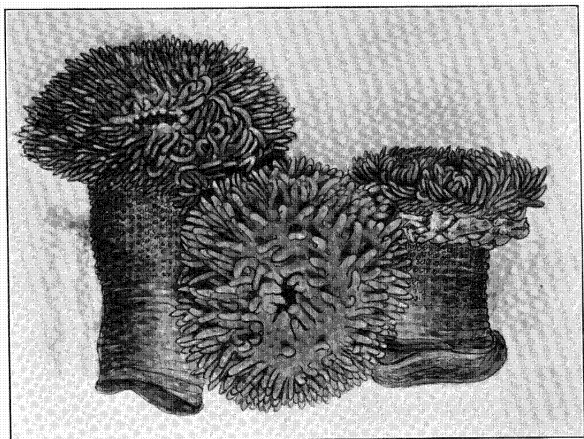


C

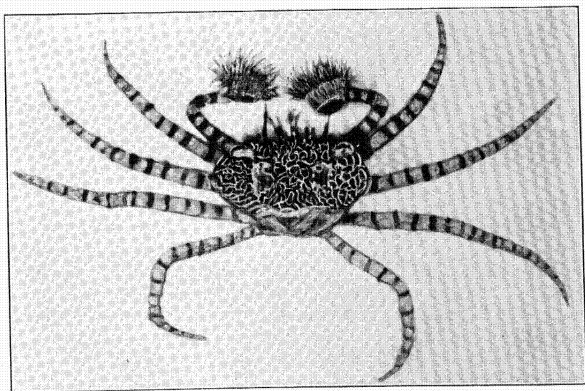


B

A, *EUPLEXAURA NEGLECTA*, VERRILL, NEW SPECIES, PHOTOGRAPH OF DRIED SPECIMEN ( $\times 1.5$ ); B, *ANTIPATHES GRANDIS* VERRILL, NEW SPECIES, PHOTOGRAPH OF DRIED SPECIMEN ( $\times 1/18$ ); C, *ANTIPATHES (?) IRREGULARIS* NEW SPECIES, PHOTOGRAPH OF DRIED SPECIMEN ( $\times 1/3$ ).

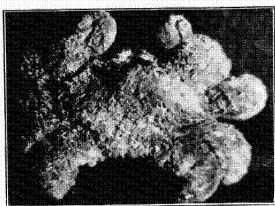


*A*

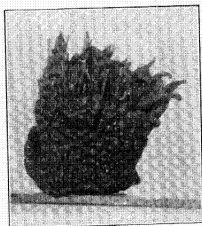


*B*

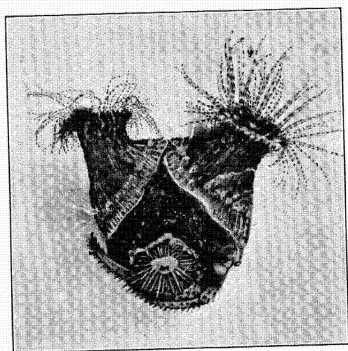
*A*, MACRANTHEA COOKEI VERRILL, NEW SPECIES, PHOTOGRAPH OF PRESERVED SPECIMEN ( $\times 1/2$ ); *B*, SAGARTIA PUGNAX VERRILL, PHOTOGRAPH OF LIVING SPECIMENS HELD IN CLAWS OF LYBIA TESSELLATA ( $\times 3$ ).



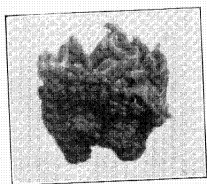
A



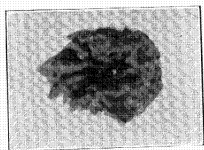
C



B



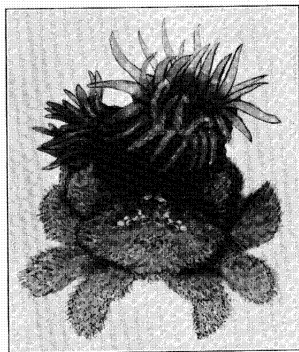
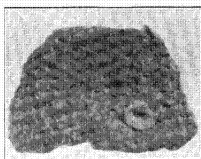
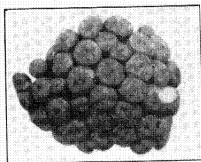
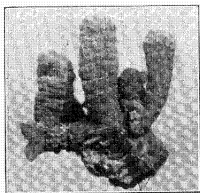
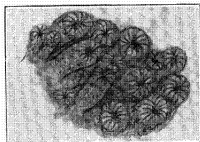
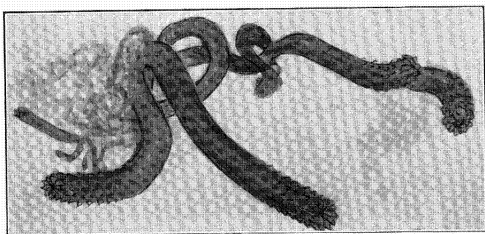
D



E

A, *SAGARTIA PUGNAX* VERRILL, NEW SPECIES, PHOTOGRAPH OF LIVING SPECIMENS HELD IN CLAWS OF *POLYDECTUS CUPULIFER* ( $\times 2$ ); B, *CALLIACTIS ARMILLATAS*, VERRILL, NEW SPECIES, PHOTOGRAPH OF LIVING SPECIMEN ON MOLLUSK SHELL CARRIED BY A HERMIT CRAB ( $\times 1/2$ ); C, *CLADACTELLA MANNI* VERRILL, NEW SPECIES, PHOTOGRAPH OF PRESERVED SPECIMEN (SLIGHTLY ENLARGED); D, E, *CLADACTELLA OBSCURA*, VERRILL, NEW SPECIES. PHOTOGRAPH OF PRESERVED SPECIMEN ( $\times 2$ ).



*A**B**C**D**F**E*

*A, B, TEALIOPSIS NIGRESCENS* VERRILL, NEW SPECIES: *A*, LIVING SPECIMENS HELD IN CLAWS OF *POLYDECTUS CUPULIFER* ( $\times 2$ ); *B*, PRESERVED SPECIMEN ( $\times 3$ ); *C*, *ZOANTHUS CONFERTUS* VERRILL, NEW SPECIES, PHOTOGRAPH OF PRESERVED COLONY LOOKING DOWN UPON POLYPS (NATURAL SIZE); *D*, *ZOANTHUS VESTITUS* VERRILL, PHOTOGRAPH OF PRESERVED SPECIMENS (NATURAL SIZE); *E*, *ISAURUS ELONGATUS* VERRILL, NEW SPECIES, PHOTOGRAPH OF PRESERVED SPECIMENS (NATURAL SIZE); *F*, *ISAURUS ELONGATUS* VERRILL, PHOTOGRAPH OF A CLUSTER OF POLYPS FROM ABOVE (NATURAL SIZE).







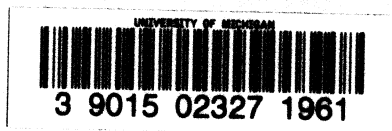




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